A Virtue Ethics Analysis of the Development of Boeing's 737 MAX Aircraft

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Between October 2018 and March 2019, a single model of Boeing aircraft, the Boeing 737 MAX airplane, was involved in two fatal crashes that occurred shortly after takeoff, claiming a total of 346 lives. Following the second crash, the Federal Aviation Agency (FAA) and aviation regulators of other countries ordered airlines to ground all Boeing 737 MAX airplanes. These planes are still currently grounded, and won't be certified to fly until approximately mid-2020 (Slotnick, 2019). Investigations into the crashes have unveiled a multitude of problems that plagued the development and certification of the 737 MAX, but the most notable flaw was a new software system that had been implemented.

Scholars and experts have debated who is to blame for these tragedies. Numerous reports have scrutinized Boeing's technology and engineering, some have examined the flight crews' procedures, while others have investigated the government oversight that allowed the plane to be certified to fly in the first place. None, however, have discussed the morality of Boeing's actions during the lifecycle of the 737 MAX. By only analyzing the technologies and regulations that failed, society is left uneducated on how to hold corporations morally responsible for their actions.

I will examine the case of Boeing's faulty 737 MAX through the lens of virtue ethics in order to show that Boeing is morally responsible for the crashes. Specifically, I will illustrate the immorality of Boeing engineers and management by showing that their actions when developing the new aircraft directly contradict several fundamental canons of ethical engineering and business: safety and honesty. Throughout the course of this paper, I will also integrate notions of risk and responsibility in order to strengthen the argument that Boeing's actions were unethical.

Literature Review

Despite the recency of the crashes, many scholarly works regarding this case already exist. The majority of these works focus on the systemic failure of Boeing's plane technology and aviation regulations, provide technical explanations to the underlying hardware and software issues that led to the two separate crashes, and also lay out guidelines on how to prevent these issues in the future. However, no moral judgements have yet been made of Boeing or its employees.

In *The Boeing 737 MAX Saga: Lessons for Software Organizations*, Johnson and Harris investigate the interconnected network of engineering, human factors, corporate behavior, and customer service that led to the Boeing crashes. Failure modes such as poor documentation, rushed release, delayed software updates, and uninformed humans are emphasized and expanded on, and the paper analyzes how the case can be viewed as a shortcoming of systems engineering. However, the paper provides no ethical commentary regarding Boeing's actions.

In *B-737 MAX and the crash of the regulatory system,* Sgobba argues that the crashes can be largely attributed to an inadequate aviation regulatory system. He states that regulatory enforcement has become less effective due to the perpetually growing skill gap between industry and regulators. He believes that this gap can be mitigated by placing an emphasis on more robust risk-based certifications and on qualitative performance requirements over quantitative ones. Sgobba uses the Boeing case to illustrate the deficiencies of current regulations, such as the process of integrating and certifying new technologies, like the computer-based system that caused the Boeing planes to crash. In his argument, he criticizes the process that allowed the Boeing 737 MAX to be certified to fly, however, there is no mention of the morality of Boeing's actions.

Both scholars detail the engineering and regulatory factors that led to the crashes and provide suggestions for preventing such disasters. While it is crucial to keep these inadequacies in mind, the current body of research fails to recognize the untapped value in considering how the character of Boeing employees contributed to the defective airplanes and the two resulting crashes. This paper will outline the engineering, management, and regulatory failures behind the development of the Boeing planes and apply a virtue ethics framework to develop a normative judgement of the actions of Boeing engineers and management.

Conceptual Framework

The morality of the actions of Boeing's employees can be analyzed with a virtue ethics framework. Developed primarily by Aristotle, virtue ethics is an ethical theory that "focuses on the nature of being a good person" and "indicates which good or desirable characteristics people should have or develop to be moral." The development of these character traits is essential in leading a good life, and in order for an individual to exist in this ideal state, he or she must possess "practical wisdom," or the ability to appropriately distinguish and apply moral virtues that exist in the middle of two extremes (van de Poel & Royakkers, 2011). For example, the virtue of courage is the equilibrium within the spectrum of cowardice and recklessness.

In virtue ethics, relevant virtues are completely situational and depend on the context of the involved individual (van de Poel & Royakkers, 2011). In the case of the Boeing 737 MAX airplanes, two different groups are under question: the engineers and management. Accordingly, I will utilize the National Society of Professional Engineers' (NSPE) Code of Ethics and Boeing's very own "Enduring Values" as the foundation of pertinent virtues for the engineers and management, respectively, for this argument. These virtues are as follows:

1. Hold paramount the safety, health, and welfare of the public
2. Perform services only in areas of their competence
3. Issue public statements only in an objective and truthful manner
4. Act for each employer or client as faithful agents or trustees
5. Avoid deceptive acts
6. Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession

Figure 1: NSPE's Code of Ethics: Fundamental Canons (NSPE, 2019)

1. Integrity
2. Quality
3. Safety
4. Diversity & Inclusion
5. Trust & Respect
6. Corporate Citizenship
7. Stakeholder Success

Figure 2: Boeing's 'Enduring Values' (Boeing, 2020)

NSPE states that engineers must follow the "Fundamental Canons" in the fulfillment of their professional duties (NSPE, 2019), and similarly, Boeing states that its "Enduring Values" allow its employees to "commit to a set of core values that not only define who we are, but also serve as guideposts to help us become the company we would like to be. And we aspire to live these values every day" (Boeing, 2020). While the two sets of virtues will be exclusively applied to the appropriate group, there is considerable conceptual overlap among them, and the virtues in question can be generalized among both groups into the ethical virtues of safety and honesty.

In order to judge the presence or absence of any one of these virtues, I examine whether or not the Boeing employees *repeatedly* acted in ways consistent (or inconsistent) with that virtue. As such, I examine the development of the 737 MAX through the context of virtue ethics, analyzing the series of decisions made by both engineers and management with respect to the NSPE's Code of Ethics and Boeing's "Enduring Values."

Analysis

The Boeing employees involved in the development of the 737 MAX lack numerous crucial virtues necessary for morally responsible behavior, however, this section will focus on safety and honesty. These virtues are central to both NSPE's Code of Ethics and Boeing's very own "Enduring Values," and while Boeing's employees may not have violated all of codes' virtues during development, it can be argued that in the context of general engineering virtues, lacking even one virtue is sufficient in deeming an individual to be immoral (Pritchard, 2001). The following sections highlight two key stages in the development process of the Boeing 737 MAX and further detail the actions of employees at each stage that detract from the indicated virtues.

On December 1, 2010, Boeing's industry rival Airbus announced the A320neo, an upgrade of its A320 plane that would be fifteen percent more fuel efficient. While this improvement seems small, it would save airlines an estimated $690 million on fuel annually (Campbell, 2019). The release of the Airbus A320neo disrupted the aviation industry, and Boeing scrambled to respond. Already months behind Airbus, Boeing's leadership was worried that the A320neo would cut into revenue and steal market share if Boeing didn't launch a competing aircraft quickly. Understandably, the company's leadership requested engineers to find possible ways to minimize time to market, and Boeing's solution was to retrofit its tried-and-true previous generation model, the 737NG, with larger engines, eliminating the need to design an entirely new plane body. On August 30, 2011, Boeing announced the 737 MAX, which claimed to be eight percent more fuel efficient than the A320neo.

Boeing's management hoped that the decision to base the platform of the 737 MAX on that of the 737NG would not only save them years of research and development and billions of

dollars, but that it would also present the opportunity to market the new 737 MAX as a mere upgrade to its predecessor. This would allow for quicker certification by the FAA because the 737 MAX would be built with the 737NG's already approved body and electronic systems. Additionally, it would allow Boeing to claim that pilots of the 737NG could transition almost seamlessly into the 737 MAX, even going as far as offering airlines a $1 million discount per plane if additional simulator training was required (Kitroeff, 2020). While this decision by leadership to forego redesign of the plane body may seem like a resourceful and even responsible choice to beat Airbus to market, it was Boeing's first, and arguably most destructive, breach of virtues. This decision ultimately cultivated a companywide culture that prioritized speed and profits over its own virtues of safety and honesty.

Development of the MCAS

In order to improve fuel efficiency, the 737 MAX would require larger engines than its predecessor. Because Boeing decided to preserve the body of the 737NG, the larger engines needed to be positioned higher and more forward on the wings than the original 737NG engines. However, the new positioning of the engines was found to destabilize the airplane during instances of high angle of attack (AoA), such as during takeoff and sharp turns, and cause a stall. To address this stalling risk, Boeing engineers developed a software solution called the Maneuvering Characteristics Augmentation System (MCAS) that would push the nose of the plane downwards when it detected too high of an AoA (Johnston and Harris, 2019), as shown in Figure 3. In theory, the system was a seemingly ingenious solution to compensate for the aerodynamic destabilization caused by engine's altered positions. However, the actions of Boeing engineers and managers during the development of the MCAS directly violate the virtue

of safety, and this combination of poor engineering and management led to the malfunction of the MCAS prior to both crashes.

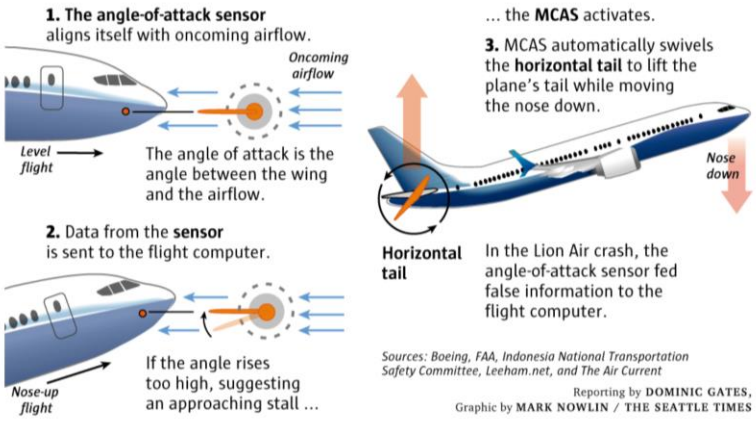

Figure 3: "How the MCAS works on a 737 MAX" (Gates, 2019)

The MCAS was programmed to receive inputs from a single AoA sensor. Therefore, it is incapable of determining whether or not the input from the sensor is accurate, nor is it capable of crosschecking with another sensor. This is referred to as a single point of failure, or a lack of redundancy. If the sensor happened to fail or give incorrect readings, the software would have no idea and would continue to use those readings to do exactly what it was programmed to do. This is precisely what happened prior to both 737 MAX crashes. In both cases, the sensor malfunctioned and fed bad AoA data to the software, and due to the lack of redundancy, the MCAS repeatedly pulled the nose of the plane downwards until it crashed (Campbell, 2019).

The engineers responsible for the development of the MCAS should never have designed the system without redundancy. Redundancy is considered "the single most important engineering tool for designing, implementing, and – importantly – proving reliability in all complex, safety-critical technologies" (Downer, 2009). The decision by Boeing's engineers to ignore redundancy and design a crucial system to rely on a single sensor is one that does not

"hold paramount the safety, health, and welfare of the public" (NSPE, 2019). By failing to advocate for such a crucial safety feature, it is evident that the Boeing engineers do not possess the virtue of safety.

However, while the engineers did not uphold the virtue of safety, I argue that Boeing's management failed to do so on a much larger scale. The 737 MAX was originally designed not only with two AoA sensors in mind, but also with a disagree light, a feature that would crosscheck between the two sensors and notify pilots if there was a large discrepancy (Johnston and Harris, 2019). This package was sold as an optional add-on to the plane, and neither plane that crashed was equipped with these features. By not making this system standard in all models, Boeing's management failed to acknowledge the safety of their customers, and also failed to take advantage of the opportunity to eliminate the lack of redundancy designed by the engineers. Boeing proudly states that safety is one of its "Enduring Values":

> We value human life and well-being above all else and take action accordingly. We are personally accountable for our own safety and collectively responsible for the safety of our teammates and workplaces, our products and services, and the customers who depend on them. When it comes to safety, there are no competing priorities. (Boeing, 2020)

When Boeing's management made the business decision to market these crucial safety features as something as trivial as leather seats or a sunroof, it is evident that profits were a competing priority to safety. This also raises the issue of informed consent. Since Boeing downplayed the need for these additional safety features, the majority of airlines opted not to spend the extra money for the package. Had the airlines known of the holes in the MCAS system, I believe that most would have purchased the package or demanded that it be included. Boeing's deception completely eliminated the customer's ability to make its own decisions by failing to lay out the

risks and consequences. This can be extended even further to the pilots of the new planes. Just as doctors are obligated to ask patients for informed consent before any medical intervention, Boeing arguably has a similar duty to ensure that the pilots responsible for the safe operation of its planes are fully informed of all critical systems. Had they known about the erratic nature of the MCAS system, they could have declined to operate the MAX or requested additional training.

Furthermore, it has come to light that Boeing managers vetoed an additional safety system that engineers had urged to implement. Curtis Ewbank, a senior engineer, had filed an internal ethics complaint after the company rejected a "synthetic airspeed" system that would notify pilots when AoA sensors were malfunctioning and prevent other systems from relying on that faulty information. He stated that managers would constantly reject safety suggestions from engineers because they would be too costly or take too much time (Kitroeff, 2019). This is yet another example of how Boeing management's gross obsession over profits and schedule caused them to act in ways contradictory to their own values of safety. In this case, the virtue of upholding safety can be seen as a mean between two extremes: saving money by implementing no safety and spending too much money on unnecessary features. Through its actions, Boeing clearly failed to find the appropriate middle ground, and both the engineers and managers lack the virtue of safety.

Certification Process

During the certification process of the 737 MAX, the FAA often delegated tasks back to Boeing, increasing the authority that Boeing had in certifying its own plane. This practice is not atypical in industry, as the FAA simply does not have the manpower or resources to conduct

everything in-house. However, the manner in which Boeing engineers and management acted when given this entrustment directly violates the virtues of safety and honesty.

Boeing took advantage of the FAA's increased delegation of tasks in order to further its interests. When Boeing submitted its initial System Safety Analysis regarding the MCAS, the FAA allowed Boeing to certify this document itself. This safety analysis, which was required to "ensure the safe operation of the 737 MAX," was approved by Boeing engineers and they concluded that the system complied with all applicable FAA regulations (Gates, 2019). It is ridiculous how the engineers would violate the trust of the FAA by approving a safety analysis for a system that they knew was unsafe. This is in direct contradiction of multiple NSPE codes (see Appendix A) regarding both safety and honesty. Code II.1.b states that "engineers shall approve only those engineering documents that are in conformity with applicable standards." The fact that the engineers approved the safety analysis, knowing that it severely downplayed the MCAS' capabilities in order to circumvent FAA regulations, shows a clear violation of safety. The engineers were cognizant of the analysis' shortcomings, yet proceeded to approve the document in order to expedite the certification process, putting profits and schedule above safety. As a result, an unsafe technology was not only pushed through, but was done so in a dishonest manner. Codes II.4 and II.5 states that "engineers shall act for each employer or client as faithful agents or trustees" and "avoid deceptive acts." Boeing's engineers exploited the FAA's process by withholding information in the analysis and taking advantage of the FAA's increased delegation of tasks. This cannot be seen as anything but a "deceptive act" or a failure to act as a "faithful agent." Even worse, it was found that following the safety analysis, Boeing increased the MCAS' ability to push the plane's nose down by a factor of four and also updated it to activate in more situations (Campbell, 2019). These actions by Boeing kept the FAA out of the

loop. During the investigations following the crashes, an FAA engineer admitted that "there wasn't a complete and proper review of the documents. Review was rushed to reach certain certification dates" (Gates, 2019). Since the agency's engineers were not made aware of the MCAS' power, their own assessments that relied on Boeing's analysis were misinformed and only elongated the trail of lies established by Boeing. The engineers' decision to approve a document which contained misleading information is inconceivable and completely disregards any commitment to safety or honesty.

Furthermore, Boeing engineers failed to demonstrate the virtue of honesty during the FAA's certification of the 737 MAX flight simulator. In one instance, a Boeing engineer said that "a presentation the company gave to the FAA was so complicated that, for the agency officials and even himself, it was like dogs watching TV" (Kitroeff, 2020). Based on Boeing's previous behavior, it is indisputable that this presentation was intentionally designed to be difficult to follow so that Boeing could mislead officials and cover up its wrongdoings. The certification of this simulator would allow Boeing to accomplish its goal in marketing the 737 MAX as a cost savings to airlines, and this presentation was an attempt to expedite the process.

A number of internal messages exchanged between Boeing engineers were also uncovered during the investigation, further highlighting a pattern of unethical behavior throughout the certification process. Among these exchanges (see Appendix C), were several particularly damning emails and messages:

> "I still haven't been forgiven by god for the covering up I did last year… Can't do it one more time. The Pearly gates will be closed."
>
> "Would you put your family on a MAX simulator trained aircraft? I wouldn't."

> "Amazing what a brown envelope can achieve… It isn't anywhere near as it would appear to be reading the report. The FAA were neither thorough nor demanding and failed to write up many issues. And the lies, the damn lies."
>
> "I just Jedi mind tricked this fools. I should be given $1000 every time I take one of these calls. I save this company a sick amount of $$$$."
>
> "What did you convince them of?"
>
> "To simply produce an email from me to the DCGA [an unnamed national aviation regulator] that states all the airlines and regulators that accept only the MAX CBT [basic training] to make them feel stupid about trying to require any additional training requirements." (Sweney & Topham, 2020)

These exchanges portray the lengths that Boeing engineers were willing to take to evade scrutiny from the FAA and public, and more importantly, provide valuable insight into the engineers' character to show that they lack the virtue of honesty. The actions implied in these messages violate not only the aforementioned NSPE Codes II.4 and II.5, but also Code II.3, which states that "engineers shall issue public statements only in an objective and truthful manner." The engineers involved in these messages clearly demonstrate that they were unfaithful agents, performed deceptive acts, and issued misleading statements. The "covering up," the "lying," and the "Jedi mind tricking" were actions that blatantly violate multiple NSPE codes pertaining to honesty, and thus, the engineers can be deemed to lack the virtue of honesty and therefore unethical.

Some may argue that the engineers were not at fault and that the blame should be placed on Boeing's management for putting the engineers in situations where they had to make unethical choices. After all, the managers were the ones who had sealed the lid to this pressure

cooker of a project, pushing tight schedules and cost reduction. Yes, it was this culture that resulted in most of the ethical issues discussed above, and yes, Boeing's management violated its own business ethics of safety and honesty when pushing this culture, but these points do not free the engineers from what they did. Even if they were forced to act immorally by management, the engineers had many opportunities to blow the whistle during the project. Their actions not only violated countless engineering ethical codes, but led to the deaths of innocent lives. NSPE Code III.2.b states that:

> Engineers shall not complete, sign, or seal plans and/or specifications that are not in conformity with applicable engineering standards. If the client or employer insists on such unprofessional conduct, they shall notify the proper authorities and withdraw from further service on the project.

Boeing's engineers approved documents that did not meet proper standards on multiple occasions, failed to notify the FAA on multiple occasions, and failed to resign on multiple occasions. Their comments (see Appendix C), while disturbing, clearly show remorse and consciousness of their wrongdoings. Yet, they did nothing. Moreover, the fact that no one spoke up during the certification stage, the last line of defense, the last chance for Boeing to right its wrongs, is most damning. The engineers put their own jobs and reputation above the public's safety, and that will always be unethical. I am not now, however, arguing that it is purely the engineers' fault. In this case, the concept of collective responsibility and the problem of many hands can be applied since responsibility does not fall on one individual but should be instead distributed amongst the collective (van de Poel & Royakkers, 2011). Therefore, Boeing engineers, management, and the company as a whole should be held morally responsible for the disasters.

Conclusion

Having investigated Boeing's actions during the stages of development and certification of the 737 MAX, both Boeing's engineers and management can be deemed immoral through the lens of virtue ethics as they repeatedly violated the virtues of safety and honesty that dictate ethical engineering and business.

While Boeing is scrambling to get its grounded flagship back in the air, it is crucial for the engineers and managers to learn from their mistakes. This case study exposes the disparity that can emerge from a company culture that priorities profits, and it shows that companies must learn to analyze decisions with not only technical and business acumen, but with ethics as well. As an employee of a company that serves millions of customers, a single decision could determine the fate of millions of lives. The right answer is rarely black and white, so it is imperative that these decisions be guided by a proper set of virtues in order to ensure the safety and success of customers, employees, and the company.

Word Count: 4023

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Appendix A

NSPE Code of Ethics

Preamble

Engineering is an important and learned profession. As members of this profession, engineers are expected to exhibit the highest standards of honesty and integrity. Engineering has a direct and vital impact on the quality of life for all people. Accordingly, the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct.

I. Fundamental Canons

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.
2. Perform services only in areas of their competence.
3. Issue public statements only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

II. Rules of Practice

1. Engineers shall hold paramount the safety, health, and welfare of the public.

a. If engineers' judgment is overruled under circumstances that endanger life or property, they shall notify their employer or client and such other authority as may be appropriate.
b. Engineers shall approve only those engineering documents that are in conformity with applicable standards.
c. Engineers shall not reveal facts, data, or information without the prior consent of the client or employer except as authorized or required by law or this Code.
d. Engineers shall not permit the use of their name or associate in business ventures with any person or firm that they believe is engaged in fraudulent or dishonest enterprise.
e. Engineers shall not aid or abet the unlawful practice of engineering by a person or firm.
f. Engineers having knowledge of any alleged violation of this Code shall report thereon to appropriate professional bodies and, when relevant, also to public authorities, and cooperate with the proper authorities in furnishing such information or assistance as may be required.

2. Engineers shall perform services only in the areas of their competence.

a. Engineers shall undertake assignments only when qualified by education or experience in the specific technical fields involved.
b. Engineers shall not affix their signatures to any plans or documents dealing with subject matter in which they lack competence, nor to any plan or document not prepared under their direction and control.
c. Engineers may accept assignments and assume responsibility for coordination of an entire project and sign and seal the engineering documents for the entire project, provided that each technical segment is signed and sealed only by the qualified engineers who prepared the segment.

3. Engineers shall issue public statements only in an objective and truthful manner.

a. Engineers shall be objective and truthful in professional reports, statements, or testimony. They shall include all relevant and pertinent information in such reports, statements, or testimony, which should bear the date indicating when it was current.
b. Engineers may express publicly technical opinions that are founded upon knowledge of the facts and competence in the subject matter.
c. Engineers shall issue no statements, criticisms, or arguments on technical matters that are inspired or paid for by interested parties, unless they have prefaced their comments by explicitly identifying the interested parties on whose behalf they are speaking, and by revealing the existence of any interest the engineers may have in the matters.

4. Engineers shall act for each employer or client as faithful agents or trustees.

a. Engineers shall disclose all known or potential conflicts of interest that could influence or appear to influence their judgment or the quality of their services.
b. Engineers shall not accept compensation, financial or otherwise, from more than one party for services on the same project, or for services pertaining to the same project, unless the circumstances are fully disclosed and agreed to by all interested parties.
c. Engineers shall not solicit or accept financial or other valuable consideration, directly or indirectly, from outside agents in connection with the work for which they are responsible.
d. Engineers in public service as members, advisors, or employees of a governmental or quasi-governmental body or department shall not participate in decisions with respect to services solicited or provided by them or their organizations in private or public engineering practice.
e. Engineers shall not solicit or accept a contract from a governmental body on which a principal or officer of their organization serves as a member.

5. Engineers shall avoid deceptive acts.

a. Engineers shall not falsify their qualifications or permit misrepresentation of their or their associates' qualifications. They shall not misrepresent or exaggerate their responsibility in or for the subject matter of prior assignments. Brochures or other presentations incident

to the solicitation of employment shall not misrepresent pertinent facts concerning employers, employees, associates, joint venturers, or past accomplishments.

b. Engineers shall not offer, give, solicit, or receive, either directly or indirectly, any contribution to influence the award of a contract by public authority, or which may be reasonably construed by the public as having the effect or intent of influencing the awarding of a contract. They shall not offer any gift or other valuable consideration in order to secure work. They shall not pay a commission, percentage, or brokerage fee in order to secure work, except to a bona fide employee or bona fide established commercial or marketing agencies retained by them.

III. Professional Obligations

1. Engineers shall be guided in all their relations by the highest standards of honesty and integrity.

a. Engineers shall acknowledge their errors and shall not distort or alter the facts.

b. Engineers shall advise their clients or employers when they believe a project will not be successful.

c. Engineers shall not accept outside employment to the detriment of their regular work or interest. Before accepting any outside engineering employment, they will notify their employers.

d. Engineers shall not attempt to attract an engineer from another employer by false or misleading pretenses.

e. Engineers shall not promote their own interest at the expense of the dignity and integrity of the profession.

f. Engineers shall treat all persons with dignity, respect, fairness, and without discrimination.

2. Engineers shall at all times strive to serve the public interest.

a. Engineers are encouraged to participate in civic affairs; career guidance for youths; and work for the advancement of the safety, health, and well-being of their community.

b. Engineers shall not complete, sign, or seal plans and/or specifications that are not in conformity with applicable engineering standards. If the client or employer insists on such unprofessional conduct, they shall notify the proper authorities and withdraw from further service on the project.

c. Engineers are encouraged to extend public knowledge and appreciation of engineering and its achievements.

d. Engineers are encouraged to adhere to the principles of sustainable development[1] in order to protect the environment for future generations.

e. Engineers shall continue their professional development throughout their careers and should keep current in their specialty fields by engaging in professional practice, participating in continuing education courses, reading in the technical literature, and attending professional meetings and seminar.

3. Engineers shall avoid all conduct or practice that deceives the public.

a. Engineers shall avoid the use of statements containing a material misrepresentation of fact or omitting a material fact.

b. Consistent with the foregoing, engineers may advertise for recruitment of personnel.

c. Consistent with the foregoing, engineers may prepare articles for the lay or technical press, but such articles shall not imply credit to the author for work performed by others.

4. Engineers shall not disclose, without consent, confidential information concerning the business affairs or technical processes of any present or former client or employer, or public body on which they serve.

a. Engineers shall not, without the consent of all interested parties, promote or arrange for new employment or practice in connection with a specific project for which the engineer has gained particular and specialized knowledge.

b. Engineers shall not, without the consent of all interested parties, participate in or represent an adversary interest in connection with a specific project or proceeding in which the engineer has gained particular specialized knowledge on behalf of a former client or employer.

5. Engineers shall not be influenced in their professional duties by conflicting interests.

a. Engineers shall not accept financial or other considerations, including free engineering designs, from material or equipment suppliers for specifying their product.

b. Engineers shall not accept commissions or allowances, directly or indirectly, from contractors or other parties dealing with clients or employers of the engineer in connection with work for which the engineer is responsible.

6. Engineers shall not attempt to obtain employment or advancement or professional engagements by untruthfully criticizing other engineers, or by other improper or questionable methods.

a. Engineers shall not request, propose, or accept a commission on a contingent basis under circumstances in which their judgment may be compromised.

b. Engineers in salaried positions shall accept part-time engineering work only to the extent consistent with policies of the employer and in accordance with ethical considerations.

c. Engineers shall not, without consent, use equipment, supplies, laboratory, or office facilities of an employer to carry on outside private practice.

7. **Engineers shall not attempt to injure, maliciously or falsely, directly or indirectly, the professional reputation, prospects, practice, or employment of other engineers. Engineers who believe others are guilty of unethical or illegal practice shall present such information to the proper authority for action.**
   a. Engineers in private practice shall not review the work of another engineer for the same client, except with the knowledge of such engineer, or unless the connection of such engineer with the work has been terminated.
   b. Engineers in governmental, industrial, or educational employ are entitled to review and evaluate the work of other engineers when so required by their employment duties.
   c. Engineers in sales or industrial employ are entitled to make engineering comparisons of represented products with products of other suppliers.

8. **Engineers shall accept personal responsibility for their professional activities, provided, however, that engineers may seek indemnification for services arising out of their practice for other than gross negligence, where the engineer's interests cannot otherwise be protected.**
   a. Engineers shall conform with state registration laws in the practice of engineering.
   b. Engineers shall not use association with a nonengineer, a corporation, or partnership as a "cloak" for unethical acts.

9. **Engineers shall give credit for engineering work to those to whom credit is due, and will recognize the proprietary interests of others.**
   a. Engineers shall, whenever possible, name the person or persons who may be individually responsible for designs, inventions, writings, or other accomplishments.
   b. Engineers using designs supplied by a client recognize that the designs remain the property of the client and may not be duplicated by the engineer for others without express permission.
   c. Engineers, before undertaking work for others in connection with which the engineer may make improvements, plans, designs, inventions, or other records that may justify copyrights or patents, should enter into a positive agreement regarding ownership.
   d. Engineers' designs, data, records, and notes referring exclusively to an employer's work are the employer's property. The employer should indemnify the engineer for use of the information for any purpose other than the original purpose.

Appendix B

Boeing's "Enduring Values"

Enduring Values

At Boeing, we are committed to a set of core values that not only define who we are, but also serve as guideposts to help us become the company we would like to be. And we aspire to live these values every day.

- **Integrity**
  We take the high road by practicing the highest ethical standards and honoring our commitments. We take personal responsibility for our own actions.
- **Quality**
  We strive for first-time quality and continuous improvement in all that we do to meet or exceed the standards of excellence stakeholders expect of us.
- **Safety**
  We value human life and well-being above all else and take action accordingly. We are personally accountable for our own safety and collectively responsible for the safety of our teammates and workplaces, our products and services, and the customers who depend on them. When it comes to safety, there are no competing priorities.
- **Diversity & Inclusion**
  We value the skills, strengths and perspectives of our diverse team. We foster a collaborative workplace that engages all employees in finding solutions for our customers that advance our common business objectives.
- **Trust & Respect**
  We act with integrity, consistency, and honesty in all that we do. We value a culture of openness and inclusion in which everyone is treated fairly and where everyone has an opportunity to contribute.
- **Corporate Citizenship**
  We are a responsible partner, neighbor and citizen to the diverse communities and customers we serve. We promote the health and wellbeing of Boeing people, their families and our communities. We protect the environment. We volunteer and financially support education and other worthy causes.
- **Stakeholder Success**
  By operating profitably and with integrity, we provide customers with best-value innovation and a competitive edge in their own markets; enable employees to work in a safe, ethical environment, with a highly attractive and competitive mix of pay and benefits, and the ability to further share in the company's success; reward investors with increasing shareholder value; conduct business lawfully and ethically with our suppliers; and help to strengthen communities around the world.

Appendix C

Boeing's Internal Emails and Messages

May 2018
"I still haven't been forgiven by god for the covering up I did last year... Can't do it one more time. The Pearly gates will be closed."

"I just received a shovel to start my journey to the hotter place."

"I'll end up there either way."

May 2018
"I'll be shocked if the FAA passes this turd."

May 2018
"I have used the words 'misleading' and 'mischaracterization' a lot over the last two years in relation to this program. I could be even more honest and use other synonyms that even better describe what has been going on".

May 2018
"Get silencer, put on end of gun, place adjacent to temple, and pull trigger - the problems stop. At this point, how can they consider continuing?"

March 2018
"Not sure I will be returning in April given this - am not lying to the FAA. Will leave that to the people who have no integrity".

February 2018
"I don't know how to refer to the very very few of us on the program who are interested only in truth..."

"Would you put your family on a MAX simulator trained aircraft? I wouldn't."

"No."

April 2017
"This airplane is designed by clowns, who in turn are supervised by monkeys."

"They expect to do only two sets of one weeks airplane testing!!! Normally the FMC [flight management computer] is tested during an entire flight test program ... Jesus, it's doomed. I said we must do much more than that."

February 2017
"Amazing what a brown envelope can achieve ... It isn't anywhere near as it would appear to be reading the report. The FAA were neither thorough nor demanding and failed to write up many issues. And the lies, the damn lies."

September 2016
"This is a joke. This airplane is ridiculous".

"We are having issues with every update we do."

"It seems like they'll never get it right. Fix one thing, break 3 others."

"No one wants to fix anything."

August 2015
"I just Jedi mind tricked this fools. I should be given $1000 every time I take one of these calls. I save this company a sick amount of $$$$."

"What did you convince them of?"

"To simply produce an email from me to the DCGA [an unnamed national aviation regulator] that states all the airlines and regulators that accept only the MAX CBT [basic training] to make them feel stupid about trying to require any additional training requirements."